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Present and Past Distribution of the Endangered Southern Illinois Woodrat (*Neotoma floridana illinoensis*)

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Abstract Recent studies of the endangered southern Illinois woodrat in southwestern Illinois indicate major population declines since 1960. The discovery of 24 sites of past populations in the Shawnee Hills, as well as past collections of woodrats, delineate an extensive historic range for this mammal in southern Illinois. Drastic reduction in population level and distribution may have been due to two periods of abnormally severe winter weather in 1912 and 1918, which caused extirpation of Shawnee Hills woodrat populations and a continuing decline in remnant populations of Pine Hills and Fountain Bluff. The decline and eventual loss of the Shawnee Hills woodrats illustrate possible limiting effects of climatic extremes on populations at the outer limits of their distribution.

The eastern woodrat (*Neotoma floridana*) is represented by nine subspecies throughout its range in the southeastern United States. One subspecies, the Illinois woodrat (*N. f. illinoensis*), is considered endangered in Illinois (Illinois Nature Preserves Commission, 1971) where active populations are isolated from those in adjacent states. Specimens of *N. f. illinoensis* have been reported 120.7 kilometers (km) (75 miles) to the west in Missouri, and 136.8 km (85 miles) to the south in Tennessee. The Allegheny race *N. f. magister* has been recorded 225.3 km (140 miles) to the southeast in Kentucky, and 281.6 km (175 miles) to the east in Indiana (Schwartz and Odum 1957).

The type specimen of the Illinois woodrat was collected from high rocky bluffs east of Wolf Lake in Union County, Illinois in 1910 (Howell, 1910). Additional collections in Illinois have been reported near Olive Branch in Alexander County (Wetzel, 1947), Pine Hills in Union County (Crim, 1961; Layne, 1958; Swayne, 1949), Fountain Bluff in Jackson County (Crim, 1961; Swayne, 1949), and Horseshoe Bluff in Jackson County (Crim, 1961).

During 1959 to 1961 and in 1966 the Cooperative Wildlife Research Laboratory of Southern Illinois University (CWRL-SIU) studied the

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three populations located at Pine Hills, Fountain Bluff and Horseshoe Bluff. The present investigation (September 1972-June 1974) examined the remnant populations at Pine Hills and Fountain Bluff, and included a search for unrecorded woodrat populations in other areas of southern Illinois, specifically the Shawnee Hills. This paper reports on the status of the remnant woodrat populations in Illinois, the past range of the woodrat in Illinois, and the possible cause of the decline.

METHODS

To determine the current status of Illinois woodrat populations, woodrat houses were located and residents live-trapped and tagged. House sites in the Pine Hills and Fountain Bluff areas were live-trapped during October, 1972 to April, 1973, and in the fall of 1973. A survey to locate unrecorded, active woodrat populations and/or confirm the existence of past populations in other areas of southern Illinois was conducted during the spring and summer of 1973. The search for additional populations was primarily in areas of postulated suitable habitat in the Shawnee Hills. Areas of past woodrat populations were identified by recovery of woodrat molars when possible, as well as by the presence of droppings, decaying leaves, bark, sticks, mast shells, and bones in abandoned house sites.

STUDY AREAS

Pine Hills

The Pine Hills, located in the Southern Section of the Ozark Division (Schwegman, 1973), is characterized by an 8.8 km (5 1/2 mile) expanse of north-south oriented massive limestone cliffs which average 24.4 meters (m) (80 feet) above the Mississippi River bottoms in southwestern Illinois (Baskett, 1925; Weller and Ekblaw, 1940). The diverse flora of this area has been described (Ashby and Kelting, 1963; Mohlenbrock, 1959; Mohlenbrock and Engh, 1964; Mohlenbrock and Voigt, 1965). The current woodrat population is concentrated within the White Oak-Hickory community of north- and east-facing slopes, and the Black Oak community of south- and west-facing slopes which were described by Ashby and Kelting (1963).

Fountain Bluff

Fountain Bluff, located 8 km (5 miles) northwest of Pine Hills, rises 61 m (200 feet) above the Mississippi River in southwestern Jackson County. This bluff is isolated and geologically distinct from Pine Hills, as the exposed strata are composed of thick deposits of sandstone (Poor, 1925). The west face of the bluff is essentially smooth, with fallen boulders along the base; the east side has only occasional outcrops and a more gradual relief. Dominant tree species are similar to those at Pine Hills, except for a local abundance of Kentucky coffee trees (*Gymnocladus dioica*) in the vicinity of the one active woodrat colony on the east side of the bluff.

Horseshoe Bluff

Horseshoe Bluff, which lies about 6.4 km (4 miles) directly east of

Fountain Bluff, is geologically and vegetatively similar to Fountain Bluff. Horseshoe Bluff is composed of fairly unresistant sandstones (Poor, 1925), which form high vertical cliffs along the west face with fallen boulders along the base.

Shawnee Hills

Unlike the limestone river bluffs of the Pine Hills, these Hills are characterized by rugged sandstone cliffs, overhanging bluffs, and eroded canyons (Schwegman, 1973). Elevations along the ridge crests are between 213.4 and 228.6 m (700 and 750 feet) above sea level, while some valleys have eroded to a depth of 61 m (200 feet) or more (Horberg, 1950). Vegetation is extremely diverse, ranging from the xerophytic scrub oak forests of the ridges to the mesophytic Beech-Sugar Maple-Tulip Tree forests of the moist ravines (Voigt and Mohlenbrock, 1964) -

RESULTS AND DISCUSSION

Pine Hills During 1959-1960, Crim (1961) located 296 woodrat houses in Pine Hills, of which approximately 70 percent were being utilized by more than 200 woodrats. During the present study, 229 woodrat houses were located, but only 27 percent were being utilized by approximately 50 woodrats. Although the number of animals and houses decreased during the past 14 years, the distribution remained somewhat constant. In 1960, 85 percent of the houses were located in three Sections (9, 16, and 21) (Klimstra, 1969); similar distribution was recorded in this study (Fig. 1). Utilization of the most favorable protective shelter along the bluffs appeared to be colonization which is probably a function of the habitat rather than gregariousness (Poole, 1940). Our study indicated that protective shelter among the bluffs and outcrops consisted of crevices, ledges, cave-like depressions, and the base of bluffs. Bluffs and outcrops were preferred for the location of woodrat houses, and as first suggested by Layne (1958), rough, broken sections of the bluff were selected over those that were smooth. Exception to this was recorded in 1960 when 10 woodrat houses were located in the trees of the bottomlands adjacent to the bluff (Crim, 1961). These less-protected houses were apparently used in the past during a period of greater woodrat abundance, but were abandoned when the population declined.

Fountain Bluff—Of 41 woodrat houses located on Fountain Bluff in 1960, 21 were active (Crim, 1961). During the present study only five active houses were located on the east side of the bluff and three woodrats (2 female, 1 male) were tagged. The decline of the Fountain Bluff population may be attributed to the lack of suitable protective shelter and the isolation from the main woodrat population at Pine Hills.

Horseshoe Bluff—In 1960, 15 active woodrat houses were located along the west face of Horseshoe Bluff and four woodrats were tagged (Crim, 1961). During the present study, no active houses were found, and no woodrats were trapped. The disappearance of the woodrat population from Horseshoe Bluff during the past 14 years emphasizes the vulnerability of small, isolated populations, particularly in areas of marginal habitat.

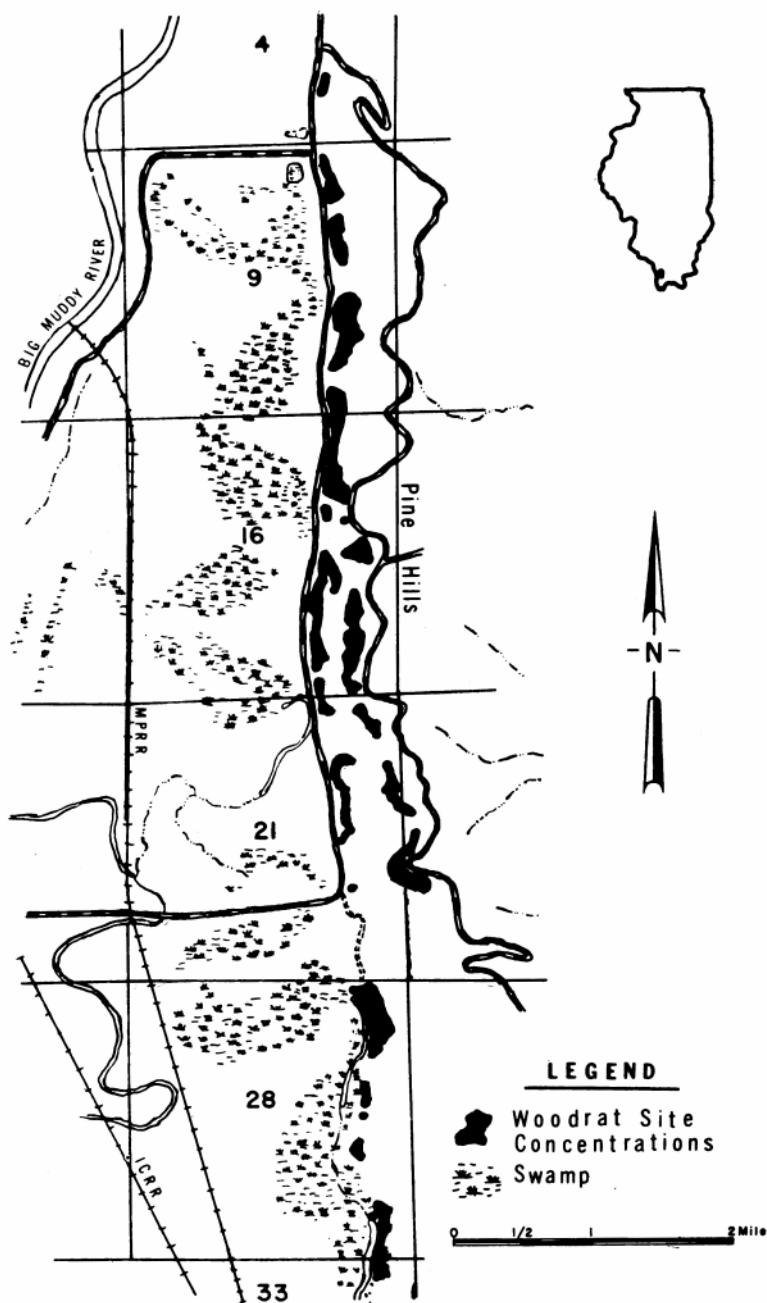


Figure 1. Distribution of woodrat sites in the Pine Hills study area, Union County, Illinois, January, 1974.

Despite the widespread availability of seemingly favorable habitat sporadically distributed along the Mississippi River bluffs, and in isolated areas of the Shawnee Hills, present woodrat populations occupy only a small portion of the available habitat in Illinois (Fig. 2) . Excavations at the Archaic (ca 8,500-1,500 B.C.) Modoc Rock Shelter in Randolph County, Illinois, and among the limestone bluffs of the Mississippi River in Monroe County, Illinois, recovered thousands of woodrat skeletal elements (Parmalee, 1959 ; Parmalee et al, 1961) . These findings establish a former prehistoric range 104.6 km (65 miles) north of the present populations at Pine Hills and Fountain Bluff. Parmalee (1967) believed that in prehistoric times woodrats commonly occurred along all sections of the Mississippi River bluffs as far as the East St. Louis area.

During the present study, 24 sites of past woodrat populations were located in the Shawnee Hills region of southern Illinois (Fig. 2, Table 1) . These findings delineate an extensive past range of the woodrat in Illinois. Twenty-three of the sites were located among fallen boulders under sandstone overhangs or on ledges and in crevices of massive sandstone outcrops. (Fig. 3) . Suspected past woodrat occupation of a cave in the sinkhole region of Hardin County, Illinois (Layne, 1958) was confirmed by the recovery of three mandibles. Although numerous caves occur throughout the Shawnee Hills (Bretz and Harris, 1961) , most are subject to extensive flooding and are not suitable woodrat habitat.

Past woodrat population sites were located among the sandstone outcrops and overhangs which border the numerous small tributaries draining the Shawnee Hills. Past populations in association with these drainage courses suggest that the extensive network of outcrop-lined tributaries provided natural avenues of dispersal which were apparently influential in the establishment of woodrat populations in the Shawnee Hills.

The distribution of past woodrat sites, as well as the abundance of well-preserved house sites, indicate that woodrats were once common in the Shawnee Hills. The areas found represent only those best-protected and preserved from weathering and disturbance, and not the complete distribution of past woodrat populations. More than 40 additional areas of seemingly suitable habitat in the Shawnee Hills contain no sign of past or current woodrat activity; however, it is likely that woodrats once occupied these areas.

All past sites contained typical woodrat middens in varying stages of preservation depending upon the amount of exposure and human disturbance. Abandoned house sites varied from small piles of debris to large middens more than 1 m wide and often more than 30 cm deep (Fig. 4) . Sites located near human habitation contained objects indicative of the presence of modern man, such as corn cobs, cow dung, broken glass, and rusty nails. Four houses located under large fallen boulders beneath sandstone overhangs were well-preserved ; entire house structures were intact, revealing tunnels within.

A well-protected woodrat house at Kerr Bluff in Union County, Illinois, contained objects from both modern man (ca 1940) and the

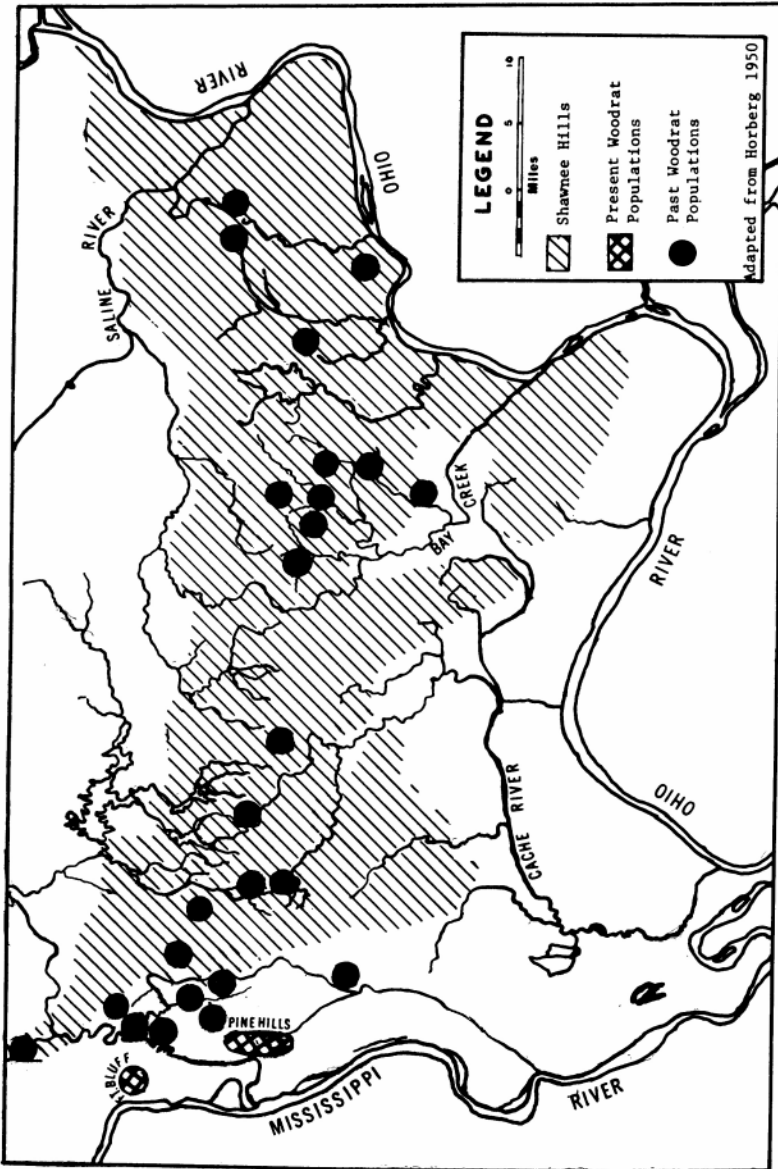


Figure 2. Distribution of present and past woodrat populations in southern Illinois.

Late Woodland Indian Period (ca 600-900 A.D.) .. The presence of Indian artifacts in the lower one-third of the house suggested a much earlier occupation of this site than was indicated by the remains of a "Diamond" brand matchbox (circulation period 1937-1945, personal communication, 1970, I. H. Koenig, Vice President, Diamond International) found among the upper 7.6 cm (3 inches) of the house.

Indian artifacts found in woodrat houses at Kerr Bluff and at One Horse Gap in Pope County, Illinois, indicate a long history of continued occupation of these favorable house sites by a succession of woodrat generations. Artifacts of recent origin at the Kerr Bluff site and others and the similar physical condition of the abandoned houses suggest that most woodrat sites in the Shawnee Hills were abandoned during the same period of time, i.e., approximately 25 to 50 years ago.

Possible Cause of the Population Decline

The complete elimination of woodrat populations from the Shawnee Hills within the last 25 to 50 years, accompanied by a gradual decline in the Pine Hills population, strongly suggests that the cause of the decline was widespread. Although the range of the woodrat in Illinois is limited to a great extent by the availability of suitable habitat, climate may be an important factor in determining the northern boundary of the range of this subspecies, especially in areas of marginal habitat. A tenable theory explaining the decline and eventual elimination of woodrat populations in the Shawnee Hills might be based upon the effect of climatic extremes on populations that have dispersed into areas of marginal habitat.

Despite a tolerance of *Neotoma* to many environmental conditions, severe winter weather appears to be a major factor in sudden woodrat population declines. Fitch and Rainey (1956) recorded a drastic decline in abundance after two winters of below-average temperatures and prolonged snow and ice cover. Significantly, this decimated population was unable to make substantial gains and continued to decline gradually for several years. The effect of severe winter weather, especially prolonged snow cover, was observed in the Pine Hills woodrat population during February and March, 1960, when as much as 35.6 cm (14 inches) of snow covered the ground for 23 days. In 1960, woodrat tracks were observed in the snow at only 2 of 86 house sites; and, woodrats weighed from 20 to 60 grams less after the snowfall than before (Unpublished Data, CWRL-SIU).

It is theorized that the decline of the southern Illinois woodrat population was precipitated by two periods of abnormally severe winter weather in 1912 and 1918 (Fig. 5). Below-average temperatures and above-average snowfall accumulations were recorded during the winter of 1912. Unusually cold temperatures (below -18°C) (below zero $^{\circ}\text{F}$) were recorded for 18 days in January, while snow covered the ground for 14 days during December and January. During the even harsher winter of 1918, snow covered the ground for 50 days in December and January, with newspaper reports of 4.6 m (15 feet) snow drifts in the western portion of the Shawnee Hills. These conditions were particularly severe for southern Illinois where winters tend to be rather mild.

Table 1. Locations of 24 areas of past woodrat populations in southern Illinois.

| | | | |
|--------------------------|---------------------------|----------|--------------|
| Cave Valley | Sect. 16 | T10S—R2W | Jackson Co. |
| Cedar Creek | Sect. 7 | T10S—R2W | Jackson Co. |
| *Cedar Creek Bluffs | Sect. 13 | T10S—R2W | Jackson Co. |
| Cove Hollow | Sect. 23 | T10S—R2W | Jackson Co. |
| *Kinkaid Lake | Sect. 31 | T8S—R3W | Jackson Co. |
| *Poplar Camp Creek | Sect. 12 & 13 | T10S—R2W | Jackson Co. |
| Rocky Hollow | Sect. 8 | T10S—R2W | Jackson Co. |
| Cliff View Park | Sect. 15 | T11S—R2W | Union Co. |
| *East Cobden Ridge | Sect. 15 | T11S—R1W | Union Co. |
| Giant City State Park | Sect. 2 | T11S—R1W | Union Co. |
| *Kerr Canyon | Sect. 22, 23, 26, & 27 | T11S—R1W | Union Co. |
| *Lick Creek | Sect. 16 | T11S—R1E | Union Co. |
| *Ferne Clyffe State Park | Sect. 22 | T11S—R2E | Johnson Co. |
| *Ozark Creek | Sect. 34 | T11S—R4E | Johnson Co. |
| *Avery Hollow | Sect. 7 | T13S—R6E | Pope Co. |
| *Bell Smith Springs | Sect. 33 | T11S—R5E | Pope Co. |
| *Brownfield Bluff | Sect. 31 | T13S—R6E | Pope Co. |
| | Sect. 36 | T13S—R5E | Pope Co. |
| Burden Falls | Sect. 15 | T11S—R5E | Pope Co. |
| *Indian Kitchen | Sect. 34 | T11S—R6E | Pope Co. |
| *Jackson Hollow | Sect. 31 | T11S—R5E | Pope Co. |
| | Sect. 6 | T12S—R5E | Pope Co. |
| *One Horse Gap | Sect. 32 | T11S—R7E | Pope Co. |
| Garden of the Gods | Sect. 36 | T10S—R7E | Gallatin Co. |
| *Pounds Escarpment | Sect. 36 | R10S—R8E | Gallatin Co. |
| *Griffith Cave | Sect. 20 | T12S—R8E | Hardin Co. |

*Denotes that at least one woodrat molar was recovered from abandoned house sites; otherwise the site consisted of droppings and typical debris.

[average temperature 4.2°C (39.5°F), average monthly snowfall 7.9 cm (3.1 inches)]. Although March, 1960, was the coldest March on record with more than 48.3 cm (19 inches) of snow (Changnon, 1964), this period of severe late winter weather did not play a role in the already extirpated woodrat populations of the Shawnee Hills.

The 1912 winter of prolonged below zero (°C) temperatures and snow cover might have precipitated the initial decline from which recovery was slow, if at all. The reduced woodrat populations were possibly further reduced and stressed by the even harsher winter of 1918. Although all of the Shawnee Hills populations may not have been eliminated as a result of the severe weather conditions, they may have been reduced to such low levels that other mortality factors would have a much greater influence in hindering or entirely eliminating recovery of the populations. Predation would have a much greater impact, since at low population levels, woodrats tend to wander greater distances between vacated houses, increasing their vulnerability (Rainey, 1956).



Figure 3. Indian Kitchen, an area of past woodrat occupation in the Shawnee Hills of southern Illinois.

Effect of Habitat Quality on the Decline

The complete elimination of woodrats from the Shawnee Hills, but not from Pine Hills, probably reflects the difference in habitat quality. Weathering and erosion of the limestone river bluffs of the Pine Hills area has resulted in far more ledges, faults, and crevices suitable for woodrat habitation than can be found among the relatively smooth sandstone outcrops and overhangs of the Shawnee Hills. Favorable habitat along the Mississippi River bluffs is also more continuous as compared to the isolated areas of marginal habitat scattered throughout the Shawnee Hills. Therefore, woodrat populations probably were able to reach their greatest density among the optimum habitat of the Pine Hills.

Due to the isolation and lower densities of the Shawnee Hills woodrat populations, the severe winter weather of 1912 and 1918 probably had a more pronounced and sudden effect on these populations than on the Pine Hills population. Apparently, the long-term effect was also less severe in Pine Hills, as the initial population density was much greater, and the remaining population was still concentrated along less than 5 km of the most desirable habitat. However, the severe winters of 1912 and 1918, and later in 1960, may have reduced the Pine Hills population eventually to an unstable level, resulting in the elimination of isolated colonies, as well as an overall population decline evidenced today.

The past occurrence of the woodrat in the Shawnee Hills, and along the northern Mississippi River bluffs, may reflect a situation similar to that of the rice rat (*Oryzomys palustris*) which in the past experienced a more northern extension of its range in Illinois (Klimstra and Scott, 1956). This northern extension seems attributable to a past period of more favorable climatic conditions. In the case of the woodrat, the recent



Figure 4. An abandoned woodrat house and midden accumulation located in Griffith Cave, Harden County, Illinois, March, 1974.

evidence of past populations in the Shawnee Hills may represent the latest expansion of the Pine Hills population into areas of marginal habitat during an earlier period of favorable climatic conditions and eruptive population growth.

Natural Repopulation of the Shawnee Hills

Natural reestablishment of the woodrat over its former range in southern Illinois would necessitate a recovery of the entire Pine Hills population to the level of peak abundance which probably existed prior to the 1920's. For repopulation to occur, a prolonged period of favorable weather would be required considering the present unstable, low population level of Pine Hills. If the Pine Hills population were able to increase, the dispersal of surplus woodrats into the previously occupied areas of the Shawnee Hills would be hindered if not impossible, due to man-made barriers and the destruction of natural dispersal routes. Present barriers to dispersal include reservoir inundation of extensive sandstone outcrops, and the isolation of outcrops and overhangs by agricultural lands, residential developments, stone quarries and highways. It is evident that natural repopulation of the former woodrat range in Illinois is now impossible under the present conditions of low population levels, habitat isolation, and habitat destruction.

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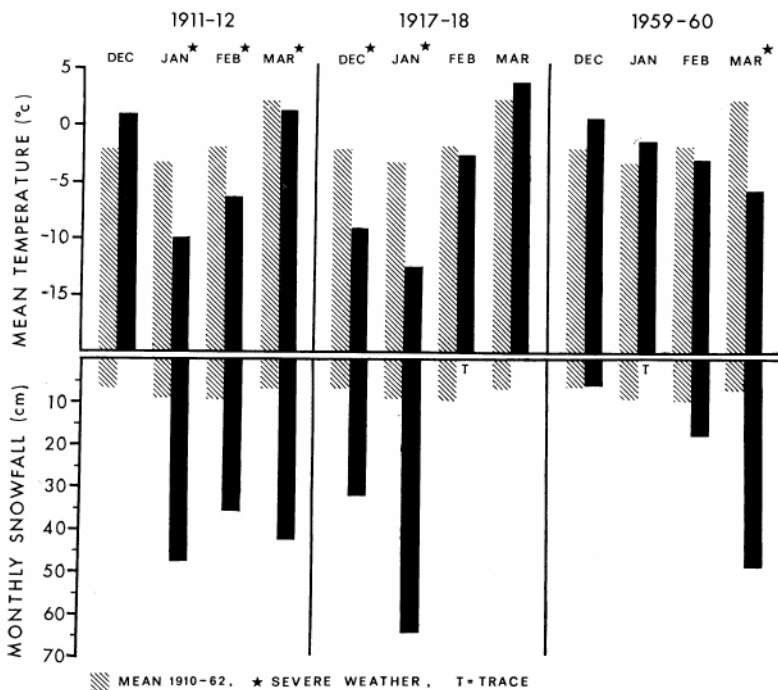


Figure 5. Climatological data for three periods of severe winter weather which may have had detrimental effects on southern Illinois woodrat populations. From Changnon (1964), Local climatological data, 1910-1962, Carbondale, Illinois.

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